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INSTRUCTION MANUAL

1251WP

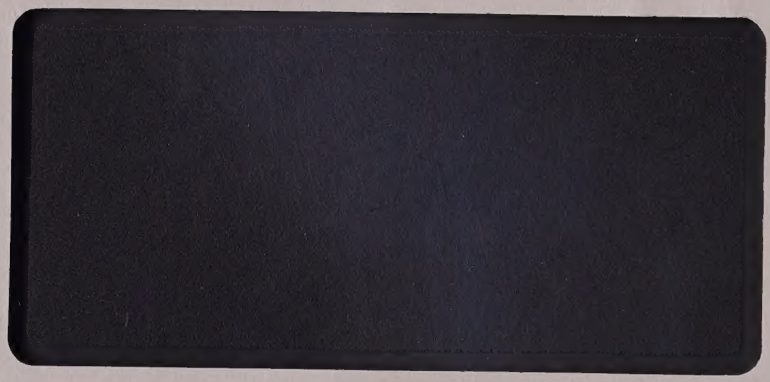
California INSTRUMENTS

Invertron® AC POWER EQUIPMENT

Convertron® DC POWER EQUIPMENT

California Instruments Corporation

9025 Balboa Avenue, San Diego, CA 92123-1509
(619) 279-8620 (800) 4-AC-POWER
FAX (619) 279-8139



California INSTRUMENTS

Original

April 1994

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P/N 5002-960

INSTRUCTION MANUAL

1251WP

SECTION 1

INTRODUCTION AND SPECIFICATIONS

1.1 INTRODUCTION

This manual contains information on the operation, calibration and maintenance of the Model 1251WP.

1.2 GENERAL DESCRIPTION

The 1251WP unit is a light weight power source that will operate from any AC source worldwide. Output is selectable for low range, 100V or 115V, operation, or high range, 220V, 230V or 240V, operation, at either 50 Hz or 60 Hz.

The universal input can be from 85 to 264 volts at 50 or 60 Hz.

The maximum output power is 1250 VA - 11 amps at 115V or 5.5 amps at 230 volts. The voltage range is selected by the rear mounted selector switches. The output voltage and frequency can be incremented $\pm 10\%$ and ± 3 Hz respectively by the front panel push button switches.

An internal dip switch on the oscillator assembly allows the selection of 220V, 230V or 240V on the high range and 100V or 115V on the low range. One high range and one low range output voltage may be selected.

SPECIFICATIONS

ELECTRICAL

Input (115 VAC, 60 Hz, unless specified otherwise)

	Line Voltage	85 - 265 VAC
	Max. Line Current (85V)	15A, Current harmonics per IEC 555-2
	Line Frequency	45 - 63 Hz
	Efficiency	≥75%
	Power Factor	0.99
	Line Inrush Current	≤30A
	Hold-Up Time	10 mS (typically 20 mS)
	Isolation Voltage (input-output)	2200 VAC
	(input chassis)	1350 VAC

Output

*	Total Power		1250 VA RMS
	Load Power Factor		0 to unity
	Current		11A (115V), 5.5 (230V)
	Repetitive Peak Current		33A (115V), 16.5A (230V)
*	Voltage Range	Low	100V or 115V
		High	220 VAC or 230 VAC or 240 VAC
		Limit Conditions	±10%
*	Total Harmonic Distortion		
	Bandwidth 30 KHz, Linear Load		≤2% (1% typical)
	Repetitive Peak Load		≤4%
	Output Noise (20 KHz to 1MHz) RMS		425 mV (115V) 850mV (230V)
	Voltage Accuracy		
	Line Regulation (10% line change)		
*	Load Regulation (Full load change)		≤2%
*	Frequency		50 Hz, 60 Hz
	Limit Conditions		±3 Hz (nominal)
	Accuracy		≤1%
	DC Offset Voltage		≤50 mV
	Isolation Voltage (output - chassis)		1350 VAC

*Denotes warranted specifications. All other specifications are supplemental.

Protection

Output Overcurrent ⊗⊗	Constant current mode 15% above rated current.
Output Short Circuit	Shutdown after approx. 5 secs. Cycle input power ON/OFF to reset.
Output Overvoltage	Shutdown, recycle input power to reset.
Input Overcurrent	Electronic Current Limit/Fuse
Input Undervoltage	Protect, automatic recovery
Input Overvoltage/Transients	Protect, automatic recovery
Overtemperature	Shutdown, automatic recovery

Control

Front Panel Controls

	Control	Indicator	Resolution	Accuracy
Output ON/OFF	✓	✓		
OVERLOAD		✓		
100V		✓		1%
115V		✓		1%
220V		✓		1%
230V		✓		1%
240V		✓		1%
50 Hz		✓		1%
60 Hz		✓		1%
Voltage +10%	✓	✓	10%	1%
Nominal	✓	✓		1%
-10%	✓	✓	10%	1%
Frequency +3 Hz	✓	✓	3 Hz	1%
Nominal	✓	✓		1%
-3%	✓	✓	3 Hz	1%
Outputs Live		✓		

⊗⊗The Model 1251WP automatically reduces the output voltage until the full load current can be delivered without gross distortion.

The overload indicator is on during this condition. Automatic reset occurs when the load is reduced.

Rear Panel Controls

Voltage	High Range, Low Range
Frequency	50 Hz, 60 Hz

Internal Controls

Low Range Setting	110V or 115V
High Range Setting	220V, or 230V, or 240V

One low range value and one high range value only may be selected.

MECHANICAL

Dimensions	8.5" (216 mm) H, 8.75" (222mm) W, 18" (457 mm) D
Weight	30 lbs. (13.6 kg)
Air Intake/Exhaust	Sides/Rear
Connectors	
- Input	IEC 320
- Output	U.S. duplex (Nema 5-15P) European (Schuko CEE7/7, square face plate)

ENVIRONMENTAL/QUALITY

Operating Temperature	0°C to 40°C
Storage Temperature	-40° to +85°C
Operating Altitude	7500 ft.
Vibration	Transportation level
Shock	Transportation level
Quality Level	Commercial components

REGULATORY

Electromagnetic Emissions	CISPR 11
Acoustic Noise	Less than 60 dBA, 3 ft., no load to 50% load, 65 dBA full load
Safety	Designed to meet UL3111 IEC1010

SECTION 2

INSTALLATION AND ACCEPTANCE

2.1 UNPACKING

Inspect the unit for any possible shipping damage immediately up receipt. If damage is evident, notify the carrier. DO NO return an instrument to the factory without prior approval. Do not destroy the packing container until the unit has been inspected for damage in shipment.

2.2 POWER REQUIREMENTS

The unit has been designed to work from any single phase supply. The IEC 320 input connector will accept a standard IEC line cord with the appropriate mating connector for the utility output. The output must be capable of supplying 1660 VA at between 85 to 265V in order to deliver full output power.

2.3 MECHANICAL

The 1251WP unit is a completely self contained portable unit. The cooling of the unit is accomplished by an internal fan that draws air in at the sides of the unit and expels it at the rear.

Both sides and rear of the unit must be kept free of obstructions and a 1" clearance from other equipment or structures should be maintained.

2.4 OUTPUT CONNECTIONS

When the low range is selected, only the duplex U.S. NEMA 5-15P output socket will be active.

If the high range is selected, only the European CEE7/7 socket will be active.

2.5 FUNCTION TEST

Ensure that the input power switch located on the rear panel is in the OFF position.

Select required output voltage and frequency by the position of the two slide switches on the back panel. NOTE: The input power should always be in the OFF position when the output range is changed.

Plug the unit into the AC power and turn the OFF/ON switch on the back of the unit to ON.

Enable the output by pressing the output ON/OFF switch on the front panel. The output "ON" light will be energized as well as one of the output voltage indicators and one of the frequency indicators. These indicators should correspond to the voltage and frequency selected. The neon lamp above the sockets will also be ON, showing power is present.

The push button switches on the front panel will select either $\pm 10\%$ output voltage and/or ± 3 Hz of the output frequency. The voltage and frequency deviation selected will be indicated by front panel LEDs.

SECTION 3

OPERATION

3.1 GENERAL

The input power ON/OFF switch and the OUTPUT VOLTAGE range switch and FREQUENCY switch are mounted on the rear panel. All other controls including the output ON/OFF switch are mounted on the front panel except for the actual individual output voltage selection which is determined by DIP switch selection inside the unit.

3.2 REAR PANEL CONTROLS

The ON/OFF switch mounted at the back of the unit interrupts both input power lines and removes all power from the unit. **The voltage selector on the rear of the unit selects either the high range of voltages (220V, 230V, 240V) or the low range of voltages (110V, 115V). These individual voltages are preset by the internal switches. (See internal controls later in this section). The frequency control switch selects either 50 Hz or 60 Hz output.

3.3 INTERNAL CONTROLS

An internal DIP switch located on the oscillator board at the front left hand side of the unit controls the HI and LOW range output voltages. Remove cover to access switches.

CAUTION

ALWAYS WAIT 5 MINUTES BEFORE REMOVING THE COVER TO ALLOW INTERNAL STORED VOLTAGES TO DECAY.

INTERNAL DIP SWITCH SELECTOR

Switch #	1	2	3	4
100	*	*	ON	X
115	*	*	OFF	X
220	OFF	ON	*	X
230	OFF	OFF	*	X
240	ON	OFF	*	X

3.4 FRONT PANEL CONTROLS

The OUTPUT ON/OFF switch, electronically inhibits the operation of the output. It does not mechanically disconnect or isolate the output wiring.

The VOLTAGE control push button switches select nominal or ±10% of the programmed output voltage. The FREQUENCY push button switches will select either nominal or ±3 Hz of the 50 or 60 Hz frequency selected.

* DON'T CARE
**SWITCH INPUT OFF BEFORE CHANGING VOLTAGE RANGE

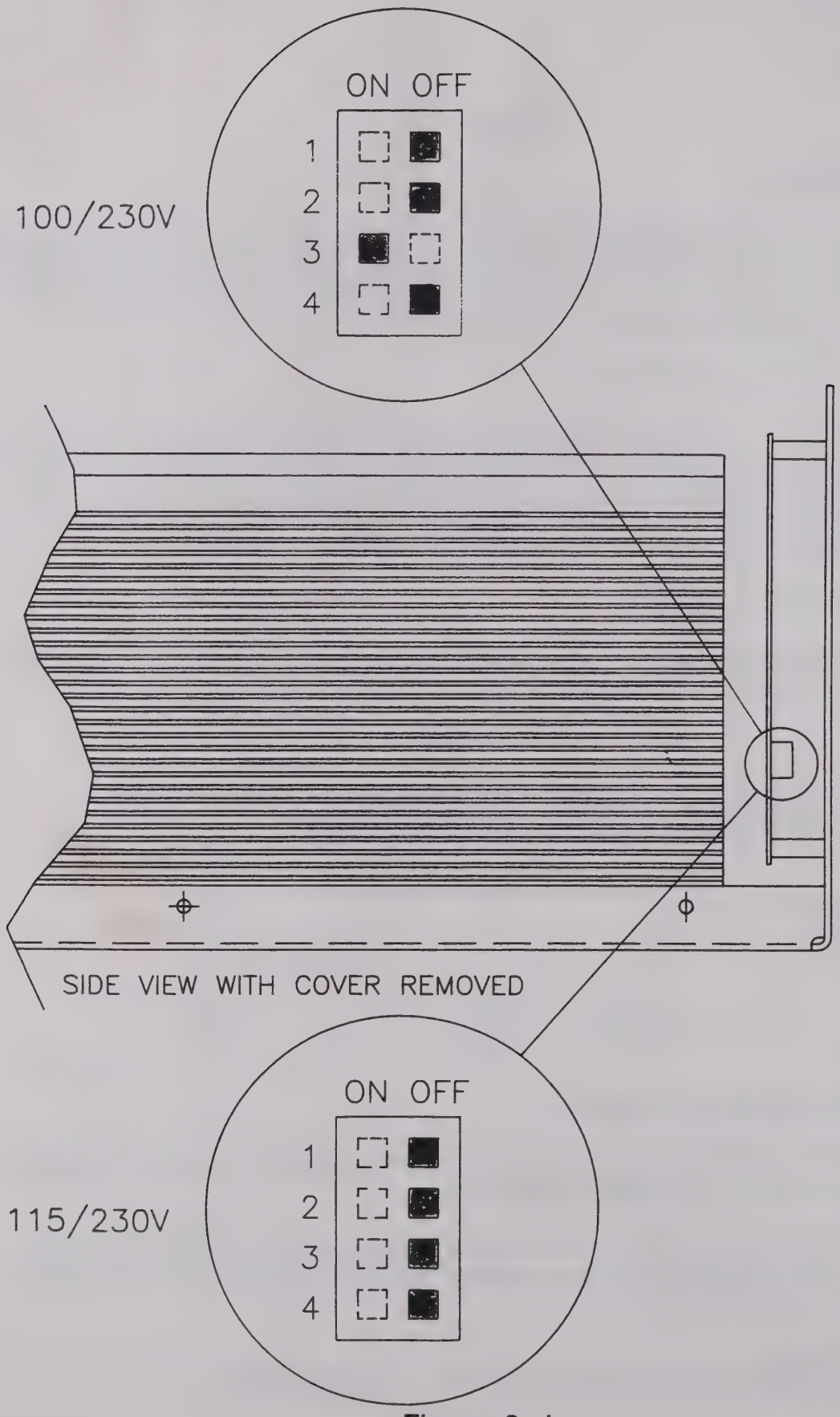

Figure 3–1

DIP SWITCH LOCATION, OSCILLATOR PC ASSY

3.5 FRONT PANEL INDICATORS

The OUTPUT ON/OFF indicator light when lit shows that the output is on. The red overload light will be lit if the output load is 5% or more than full rated load.

The appropriate VOLTAGE indicator light will be lit once the unit is energized, even if the output ON/OFF switch is off. The LEDs next to the VOLTAGE select switches will be lit to show whether +10%, nominal, or -10% has been selected.

In the FREQUENCY control panel section either the 50 Hz or 60 Hz indicator will be lit. The +3 Hz, nominal, or -3 Hz LED will be on depending on the selection mode.

Output voltage light above outlets will be lit whenever high voltage is present.

3.6 REAR PANEL CONNECTIONS

An IEC 320 type input connector is provided for input power. The input cord must be sized correctly to carry the input current at the input operating voltage. This is 15A at low input voltages, (85-126V), or 7.5A at high input voltages (200V to 265V).

3.7 FRONT PANEL CONNECTIONS

The output is available from a duplex USA style connector and a single European style connector. If the low range is selected, the US style connector is live and the European connector is not active. If the high range is selected then only the European connector can deliver power. When the power is present on the output sockets, the neon lamp above them will be lit.

SECTION 4

CALIBRATION

4.1 GENERAL

Calibration is not normally required as all modules are factory preset and sealed in order for them to be field interchangeable. A digital multimeter may be connected to the output sockets and the different output voltages selected to verify that the output is within the accuracy specified in the "SPECIFICATIONS".

A frequency or Universal Counter with an accuracy of greater than 0.1% may be used to verify the output frequency accuracy. The frequency counter should be connected by means of a 10:1 probe to prevent damage to the input circuits.

SECTION 5

THEORY OF OPERATION

5.1 GENERAL

The unit is designed to be operated from any supply from 85 to 264 volts AC, 50 or 60 Hz and deliver any one of 5 preset voltages from 100 to 240 volts at either 50 or 60 Hz.

5.2 OVERALL DESCRIPTION (See Figure 5-1)

The AC input is fed to a power factor-correcting, boost-type converter. This converter steps the voltage up to 385 VDC while drawing only sinusoidal unity power factor current from the input power line.

The DC to DC converter provides isolation and changes the voltage to 250 VDC or 400 VDC depending on whether the low output range or high output range is selected.

The A.C. converter develops an AC sine wave voltage at the output that is either 50 or 60 Hz depending what is selected.

The oscillator board provides the reference signal to the AC converter and has the front panel switches mounted on it to control the output frequency and voltage.

5.3 P.F.C. MODULE (See Figure 5-2.)

The P.F.C. consists of an input EMI filter, input bridge and a boost converter. The boost converter is PWM controlled by a single chip that adjusts the pulse width during the cycle so that only a pure sine wave CURRENT is drawn from the supply. An auxiliary winding on the boost inductor provides "bootstrap" power to the logic circuits and is self sustaining.

5.4 DC-DC CONVERTER MODULE

The 385 VDC from the boost converter is fed to the DC-DC module. It first supplies 385 volts DC to the Auxiliary Power Supply (Aux. P.S.). When the Aux starts up and runs, it supplies 6 isolated logic level supplies to the A.C. module. It also supplies 15 volts to the D.C. converter on the same D.C. module. The DC-DC converter then can start running. The D.C. converter supplies either 250 volts DC or 400V DC to the DC-AC module.

The DC-DC converter is a full bridge converter and the auxiliary converter is a two FET forward converter.

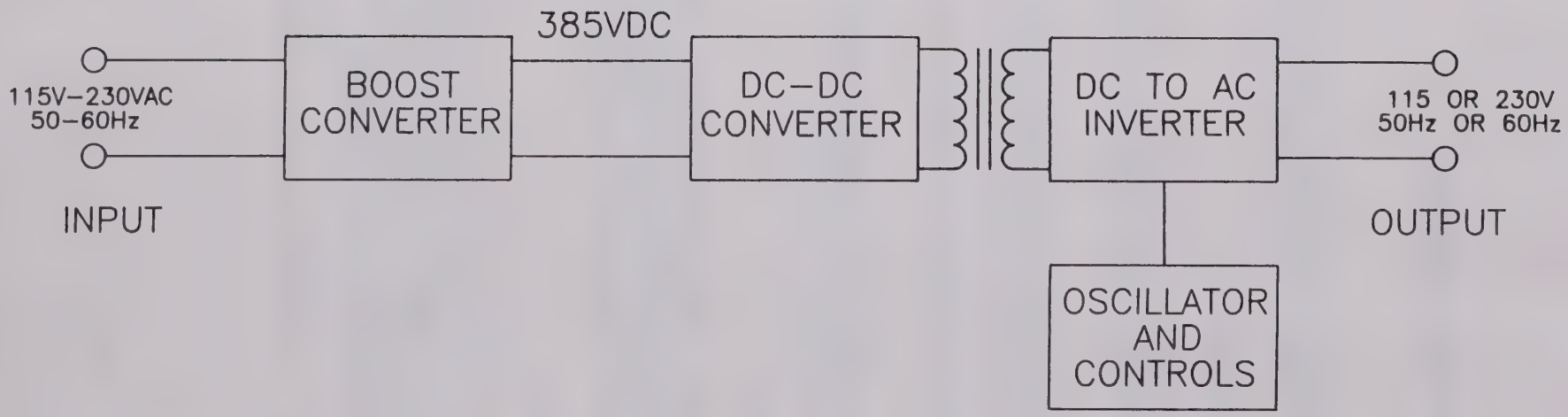

Figure 5–1
BLOCK DIAGRAM
PORTABLE FREQUENCY CONVERTER

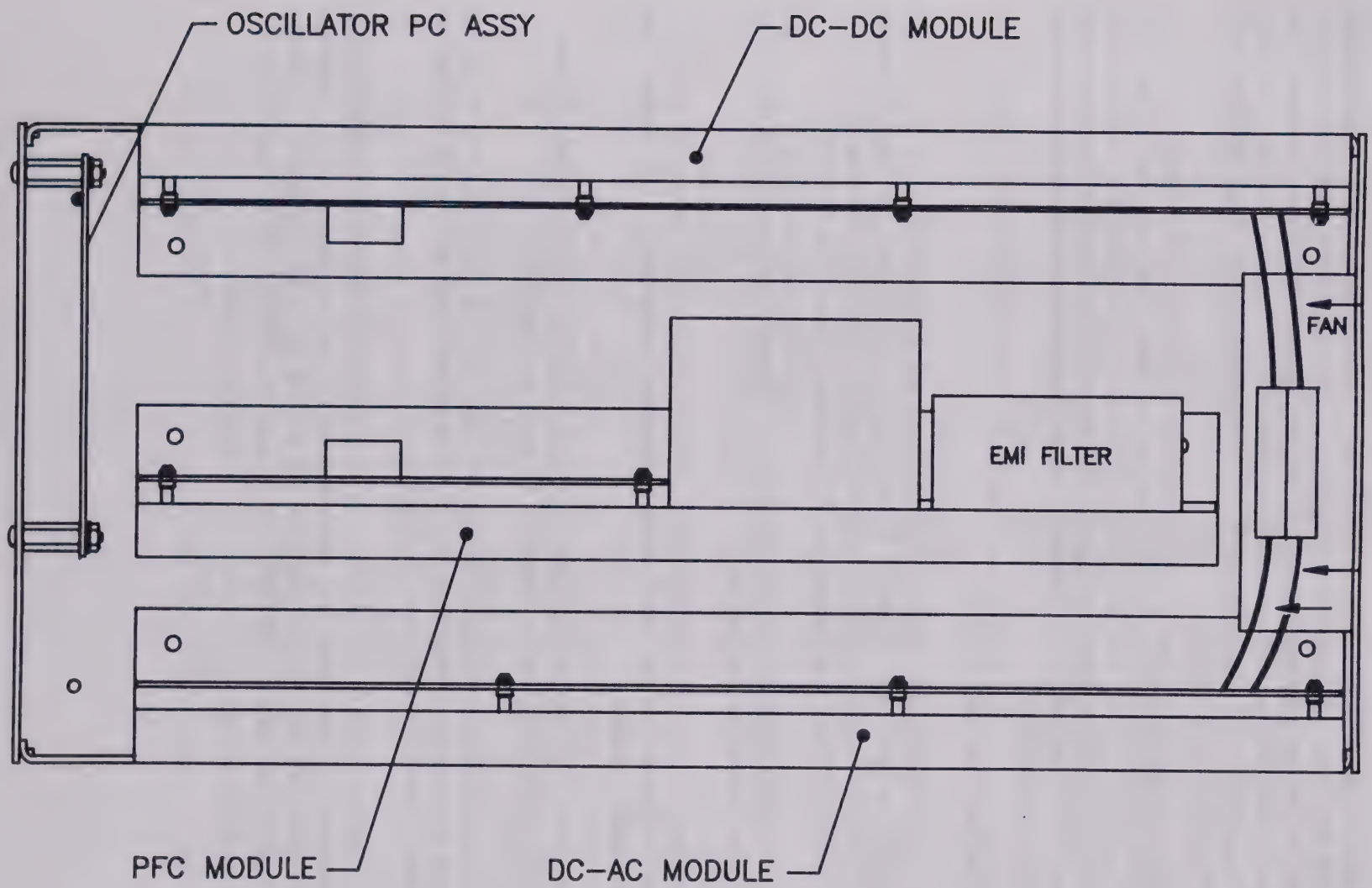

Figure 5–2

1251WP TOP VIEW
(WITH COVER REMOVED)

All the 8 LEDs on the DC-DC board should be lit under normal operation. The LED DS200 is lit when the DC output is up and within regulation. The amber LEDs DS5, DS4 and DS3 indicate that 15V power to the optocouplers on the AC Converter are within regulation. The red and green LEDs DS7 and DS6 indicate logic power OK to the AC converter. The LED DS8 shows logic power to the DC converter is within specifications at 15 volts. The LED DS2 shows 24 volt fan power is available.

5.5 OSCILLATOR BOARD

The oscillator board receives power from the DC-AC module. This board uses programmable logic devices, PLDs, to control the frequency and amplitude of the reference signal used to control the AC converter output.

5.6 DC-AC POWER MODULE

The DC to AC Power Module takes a 250V DC input and generates the 100V or 115 volt directly coupled low range A.C. outputs. When supplied with 400 volts DC the AC module develops a 220V, 230V or 240V directly coupled AC output. The output converter is a P.W.M full bridge with L.C. filtering on the output. The switching frequency is 31.25 KHz.

The module has pulse by pulse peak current limit and sinusoidal average current limiting to protect the power transistors and the load.

A slight overload of 20% will cause the output voltage to sinusoidally decrease in a constant current mode (e.g. output voltage would reduce to 100V at 13 Amps on the 115V output range) after approximately 1 second.

A heavy overload slowly applied will cause the output voltage to sinusoidally reduce down to 15 to 20 volts and the current to be constant at 13 Amps approximately.

Reducing the load to zero ohms (short circuit) will cause the peak current limit to come into effect limiting the current peaks to 35 Amps. This will continue for 3 to 5 seconds and then the unit will latch off until AC input power is recycled.

Applying a sudden overload (e.g. 3 ohms to a 115V output) will cause the converters supplying the AC converter to go into current limit and reduce the DC bus available to the AC converter. The AC converter will be forced to peak clip, flat topping the output waveform. After one second, the output will reduce sinusoidally into the constant current mode of 1 and 2 above.

SECTION 6

MAINTENANCE AND TROUBLESHOOTING

6.1 GENERAL

This section describes the suggested maintenance and troubleshooting procedures. Table 6.1 lists the symptoms and paragraph numbers for the troubleshooting section. If the frequency converter does not appear to function normally use this section to isolate the problem. The troubleshooting is broken down into two sections; first level and advanced. Only qualified electronic technicians should attempt the advanced troubleshooting section.

If the problem cannot be found using these steps, consult the factory.

TABLE 6-1

PARAGRAPH		PAGE NO.
6.2	POOR OUTPUT VOLTAGE REGULATION	14
6.3	OVERLOAD LIGHT ON	14
6.4	DISTORTED OUTPUT	15
6.5	UNIT SHUTS DOWN AFTER 3-5 SECONDS	15
6.6	NO OUTPUT	15

6.2 POOR OUTPUT VOLTAGE REGULATION

a)	Unit is overloaded	Remove overload
b)	Unit is switched to wrong voltage range, causing overload	Turn off unit and select correct output voltage range.
c)	Input line has fallen below 85 volts	Check supply voltage.

6.3 OVERLOAD LIGHT IS ON

a)	Unit is overloaded	Remove overload
b)	Unit is switched to too high voltage range	Turn off unit and select correct output voltage range

6.4 DISTORTED OUTPUT

The AC power system output may have a distorted sine wave from the following causes:

a)	Power source is grossly overloaded	Reduce overload
b)	The crest factor of the load exceeds 3:1	Reduce load current peaks

6.5 UNIT SHUTS DOWN AFTER 3-5 SECONDS

If the unit appears to run but shuts down after 3-5 seconds, it is probably due to one of the following causes:

a)	Output shorted	Remove output short
b)	Output grossly overloaded	Remove overload
c)	Operating load with too high inrush or start up currents that last more than 3 seconds	Consult factory for application advice

6.6 NO OUTPUT

a)	No output and no lights on front panel	Is the rear panel power switch in the "ON" position? Is unit plugged in to a "live" supply? Are power cords in good condition? Is fuse blown? Check fuse and replace with same type and rating.
b)	No output but LEDs on front panel are lit.	Is "output on" switch depressed? Is power cord plugged into the correct socket output? Only the USA socket is energized when low range is selected, etc. Is the appliance being operated switched on?

6.7 ADVANCED TROUBLESHOOTING. ONLY PERSONNEL WITH ELECTRICAL/ELECTRONIC KNOWLEDGE SHOULD PROCEED BEYOND THIS POINT.

CAUTION

Voltages up to 480 VAC are available in certain sections of this power source. This equipment generates potentially lethal voltages.

DEATH
on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied.

Switch off unit. Remove line cord and wait 5 minutes for all internal capacitors to discharge.

Remove cover screws and remove cover.

Step 1: Ensure all connectors are properly mated and there are no broken wires.

Step 2: Plug unit in and observe the LEDs.

a) No output, no front panel LEDs

Is LED on P.F.C. unit lit? OK if flickering with no load on output. If not lit, check input fuse and wiring on P.F.C. module. P.F.C. module is the one in the center. If lamp is not lit and power is available at the EMI filter, replace P.F.C. module.
If LED is lit, proceed to DC-DC converter. The DC-DC converter is on the left hand side when looking at the front. Are LEDs lit on the DC to DC board?

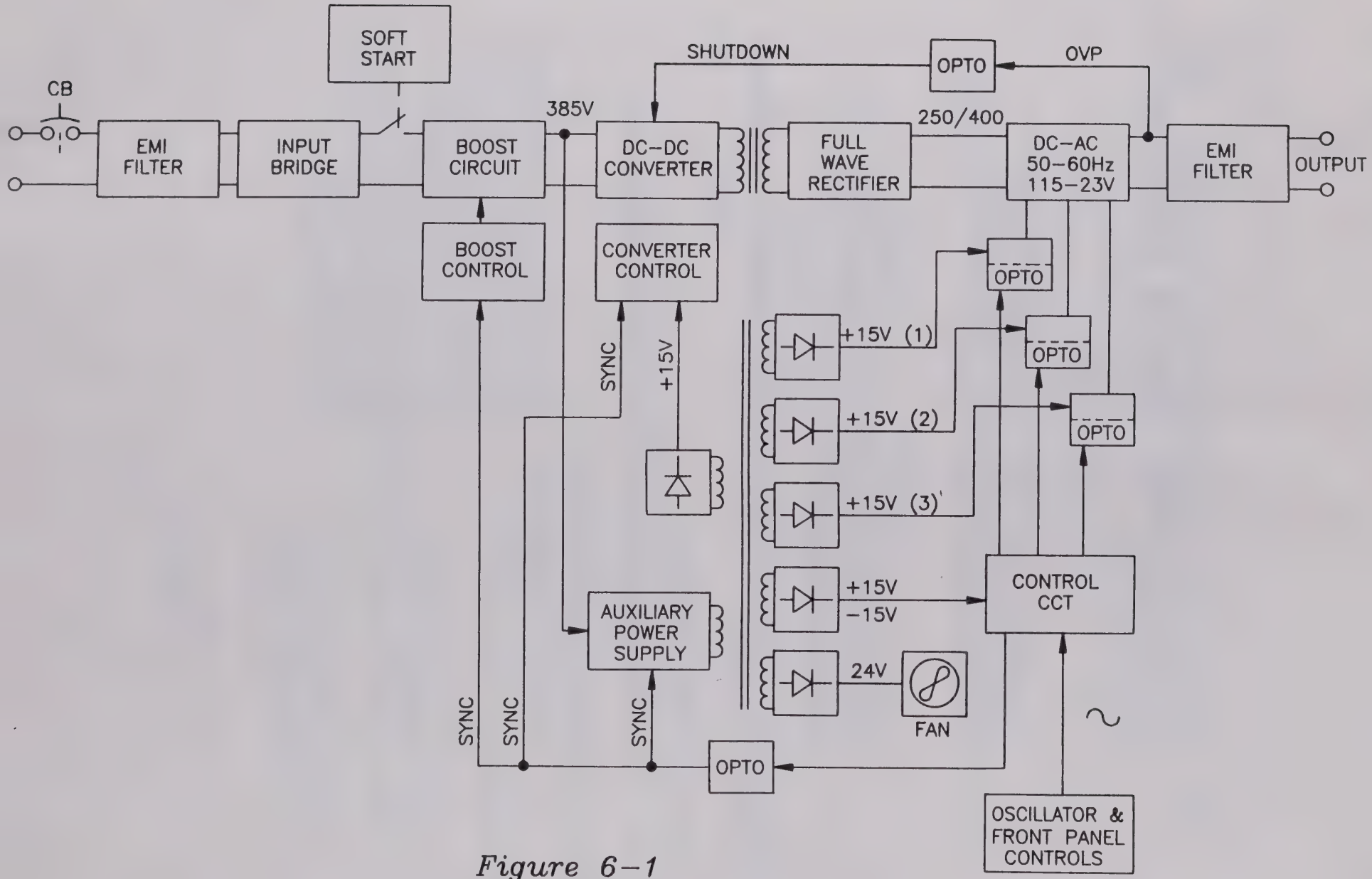

Figure 6–1
BLOCK DIAGRAM
PORTABLE FREQUENCY CONVERTER

	YES	NO
	If LEDs on the DC-DC board are lit and front panel LEDs are not lit, the problem is probably in the large ribbon cable that runs between the DC-DC and the AC converter.	Check fuses on the DC-DC converter board. There is a 1 AMP (F2) fuse and a 10 Amp (F1) fuse both located in the center of the PC board. You will have to remove the two screws at the bottom of the unit to remove the module in order to replace the fuses. **TURN OFF THE UNIT AND WAIT 5 MINUTES BEFORE REMOVING MODULE.** If fuses are blown and there are signs of burn marks on the components, do not replace fuses and power up. Replace DC-DC module.
b)	No output. LEDs on front are lit.	Plug unit in and switch on. Are all the LEDs lit on the DC-DC board? 3 amber LEDs (DS3, DS4, DS5) - if one or more of these LEDs is not lit the trouble is on the DC-AC board. Unplug the cable to the DC-AC module (after safely removing power). If all the LEDs are lit after power up, replace the DC-AC module as it has a shorted gate drive and probably blown power transistors. Red and green LEDs, DS6 and DS7, on the back of the board provide power to DC-AC and the oscillator board. If either of these are not lit, switch off power, remove large ribbon cable from DC-DC converter and power up again. If LEDs are lit, the problem is on the DC-AC or the oscillator board. If the LEDs remain off, replace the DC-DC board. If LED, DS8, is not lit, no power will be available to run the DC converter drive logic. Replace DC-DC module. LED, DS2 (red), indicates 24V fan power available. LED, DS200, will be lit if the DC converter is running. If DS200 is not lit check fuse F1 on the DC-DC board as in paragraph 6.7(a) above. If all LEDs are lit and neon output voltage indicator is ON but no output, then suspect relay on DC-AC board.

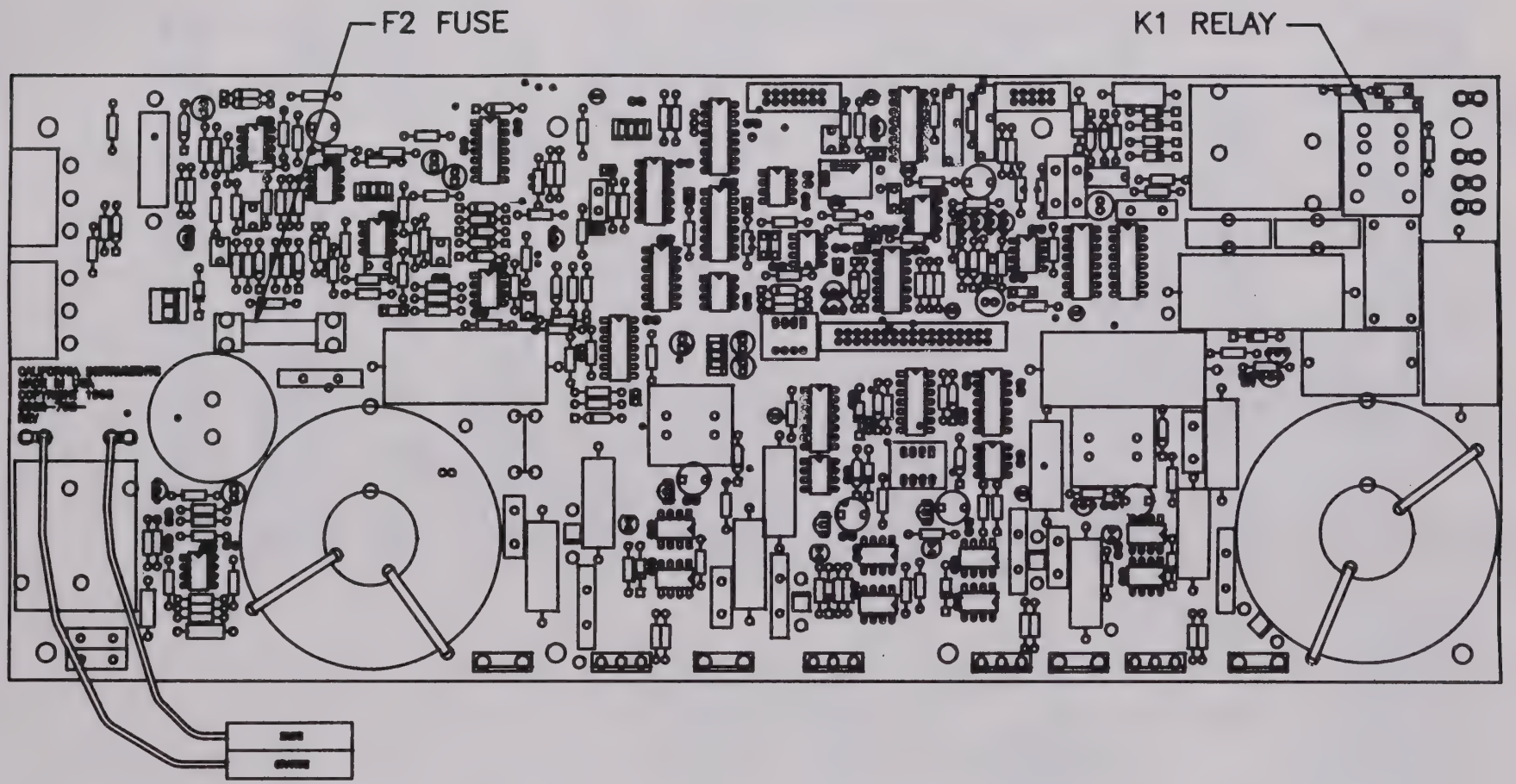

Figure 6-4

FUSE AND RELAY LOCATION
DC-AC MODULE

If all 8 LEDs are lit on the DC-DC converter then the problem is on the DC-AC module. Switch off, then check wiring from the DC-AC board output to the output sockets on the front panel. If this is OK check the fuse, F2, on the DC-AC module. Switch off. Remove two screws from the underside of the enclosure to gain access to the module and F2. If the fuse is blown and a check shows signs of damage or burning on the board, **DO NOT REPLACE FUSE.** Replace DC-AC module. If there are no signs of burning or damage on the DC-AC board or components, then it could be assumed that it is a random fuse failure and it would be OK to replace the fuse and try again.

WARNING

In most cases when a fuse blows it is caused by a failed power semiconductor and repeatedly replacing a fuse will only cause severe damage to that or other assemblies.

SECTION 7

REPLACEABLE PARTS

7.1 GENERAL

This section contains ordering information and a list of replaceable parts. The list includes the parts description and California Instruments part numbers.

7.2 ORDERING INFORMATION

In order to ensure prompt, accurate service, please provide the following information, when applicable for each replacement part ordered.

a. Model number and serial number of the instrument.

b. California Instruments part number for the subassembly where the component is located. (PARENT ITEM NO.)

c. Component reference designator. (SEQ NO.)

d. Component description.

e. Component manufacturers' FSCM number. (VENDOR)

f. California Instruments' part number (COMPONENT ITEM NO.)

All replaceable part orders should be addressed to:

California Instruments
Attention: Customer Service
9025 Balboa Avenue
San Diego, California 92123-1509

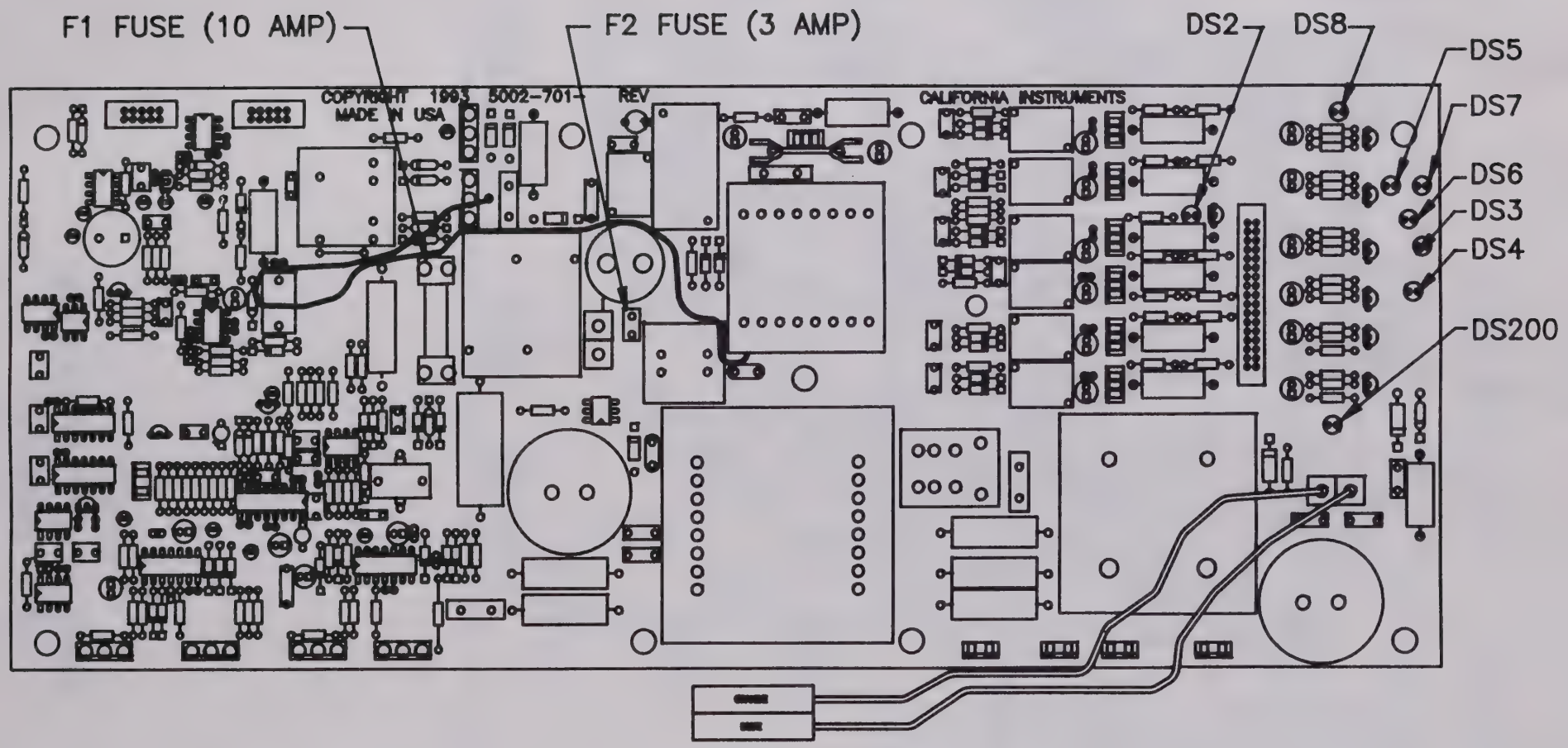

Figure 6-3

FUSE AND LED LOCATIONS
DC-DC MODULE

1251 WP

TABLE OF CONTENTS

SECTION	DESCRIPTION	PAGE
1	INTRODUCTION AND SPECIFICATIONS	1
	1.1 INTRODUCTION	1
	1.2 GENERAL DESCRIPTION	1
2	INSTALLATION AND ACCEPTANCE	5
	2.1 UNPACKING	5
	2.2 POWER REQUIREMENTS	5
	2.3 MECHANICAL	5
	2.4 OUTPUT CONNECTIONS	5
	2.5 FUNCTION TEST	5
3	OPERATION	6
	3.1 GENERAL	6
	3.2 REAR PANEL CONTROLS	6
	3.3 INTERNAL CONTROLS	6
	3.4 FRONT PANEL CONTROLS	6
	3.5 FRONT PANEL INDICATORS	8
	3.6 REAR PANEL CONNECTIONS	8
	3.7 FRONT PANEL CONNECTIONS	8
4	CALIBRATION	9
	4.1 GENERAL	9
5	THEORY OF OPERATION	10
	5.1 GENERAL	10
	5.2 OVERALL DESCRIPTION	10
	5.3 P.F.C. MODULE	10
	5.4 DC-DC CONVERTER MODULE	10
	5.5 OSCILLATOR BOARD	13
	5.6 DC-AC POWER MODULE	13
6	MAINTENANCE AND TROUBLESHOOTING	14
	6.1 GENERAL	14
	6.2 POOR OUTPUT VOLTAGE REGULATION	14
	6.3 OVERLOAD LIGHT IS ON	14
	6.4 DISTORTED OUTPUT	15
	6.5 UNIT SHUTS DOWN AFTER 3-5 SECONDS	15
	6.6 NO OUTPUT	15
	6.7 ADVANCED TROUBLESHOOTING	16

SECTION	DESCRIPTION	PAGE
7	REPLACEABLE PARTS	23
	7.1 GENERAL	23
	7,2 ORDERING INFORMATION	23

LIST OF ILLUSTRATIONS

FIGURE	DESCRIPTION	PAGE
3-1	DIP SWITCH LOCATION, OSCILLATOR PC ASSY	7
5-1	BLOCK DIAGRAM PORTABLE FREQUENCY CONVERTER	11
5-2	1251WP TOP VIEW (WITH COVER REMOVED)	12
6-1	BLOCK DIAGRAM PORTABLE FREQUENCY CONVERTER	17
6-2	TEST POINT LOCATION PFC MODULE	18
6-3	FUSE AND LED LOCATIONS DC-DC MODULE	19
6-4	FUSE AND RELAY LOCATION DC-AC MODULE	20

LIST OF TABLES

TABLE	DESCRIPTION	PAGE
6-1	TROUBLESHOOTING	14

Appendix A

Number	Vendor Name	City	State
0000A	Electricord	Westfield	PA
0000C	Jackson Bros.	Waddon,Surrey	GB
0000S(28564)	OPCDA (Refac Elect. Corp.)	Winsted	CT
0000W	Milton Ross Co.	Southampton	PA
00001(52745)	Timco	Los Angeles	CA
000AC	Itac	Santa Clara	CA
000AD(55112)	Plessey (Westlake Cap. Inc.)	Westlake Village	CA
000AG	Lafrance	Philadelphia	PA
000AH(54363)	Jan Crystal	Ft. Myers	CA
000AL(53495)	Data Components, Inc.	Gardena	CA
000AM	Kraus & Naimer	Santa Monica	CA
000AW	Ritz Instrument Transformer	Redondo Beach	CA
000AS	Switches Incorporated	Mt. View	CA
000AT(62643)	United Chemi-Con	Rosemont	IL
000AU	JMJ Technical Prod. Inc.	Kendall Park	NJ
000AV(61837)	Semi Processes, Inc.	San Jose	CA
000AW	Hirose	Chatsworth	CA
000AX(63878)	Aptronics	Mentor	OH
000AY	Silicon Power Cube Corp.	Long Beach	CA
000AZ(61271)	Fujitsu	Santa Clara	CA
000BA(61964)	Omron Electronics, Inc.	Schaumburg	IL
000BB	Hallmark Metals, Inc.	Glendora	CA
000BC	Toshiba America, Inc.	Tustin	CA
000BD(55982)	Electronic Essentials	Woodside	NY
000BE(57856)	Kel-Am	Eldon	MO
000BF(55285)	Berquist	Minneapolis	MN
000BG	Panasonic	Secaucus	NY
000BH	Century Components	Canyon Country	CA
000BI(54186)	Micro Power Systems	Santa Clara	CA
000BJ(06776)	Robinson Nugent	New Albany	IN
000BL(13150)	Beau Products (Vernitron)	Laconia	NH
000BM(91725)	Corebinder (Gerrard AJ & Co.)	Des Plaines	IL
000BO	Mitsubishi Electronics Amer.	Sunnyvale	CA
000BP	Silicon Power Cube	Long Beach	CA
000BR	Secme	Bagnolet	France
000BS	Panel Components Corp.	Santa Rosa	CA
00544	Metal-Cal Div., Avery Prod.	Inglewood	CA
00779	AMP Inc.	Harrisburg	PA
00853	Sangamo Electronic Co.	Pickens	SC
00866	Goe Eng. Co., Inc.	City of Industry	CA
01002	G.E. Co., Ind. & Pwr. Cap. Dept.	John St. Hudson Falls	NY
01121	Allen-Bradley Co.	Milwaukee	WI
01139	G.E. Co., Silicone Prod.	Waterford	NY
01295	Texas Instruments	Dallas	TX
01961	Pulse Engineering, Inc.	San Diego	CA
02111	Spectrol Electronics	City of Industry	CA
02113	Coilcraft. Inc.	Cary	IL
02335	Fairchild Controls Corp.	Hicksville,LI	NY
02375	American Insulating Mach. Co.	Philadelphia	PA
02538	Texas Electronics Co.	Dallas	TX
02660	Amphenol Corporation	Broadview	IL
02768	Illinois Tool Works, Inc. Use Code 172136	Des Plains	IL
02799	General Electric Company	Syracuse	NY
03508	General Electric Company	Syracuse	NY
03797	Eldema Corporation	Compton	CA
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls	NJ
03911	Clairex Corporation	New York	NY
04009	Arrow-Hart and Hegeman Elec.	Hartford	CT
04099	Capco, Inc.	Grand Junction	CO
04713	Motorola Semiconductor Prod.	Phoenix	AZ
04729	Universal Components Corp.	Green Brook	NJ
04963	3-M	St. Paul	MN
05245	Corcom Inc.	Chicago	IL
05276	Pomona Electronics., Inc.	Pomona	CA
05397	Kemet, Union Carbide Corp.	Cleveland	OH
05791	Lyn-Tron, Inc.	Burbank	CA
05820	Wakefield Engineering, Inc.	Wakefield	MA
05972	Loctite Corp.	Newington	CT
06383	Panduit Corp.	Tinley Park	IL
06514	Stantron, Wyco Metal Prod.	N. Hollywood	CA
06540	Amatom Elect. Hardware	New Rochelle	NY
06665	Precision Monolithics Inc.	Santa Clara	CA
06776	Robinson Nugent, Inc.	New Albany	IN
06915	Richco Plastics, Co.	Chicago	IL
07088	Kelvin Electric Company	Van Nuys	CA
07263	Fairchild Camera & Instr.	Mt. View	CA
07387	Birtcher Corporation	Los Angeles	CA
07556	Umitrack Calabro Plastics	Upper Darby	PA
07633	Epoxy Prod. Co., Allied Prod. Corp.	New Haven	CT
07707	USM Corp. (OSM Fastener Div)	Shelton	CT
07716	IRC Incorporated	Burrington	IA
07910	Use Code #15818		
08028	Loctite (Auto & Consumer Grp)	Mtn View	CA
08057	Spang Ind. (Magnetics Div)	Sandy Lake	PA
08065	Accurate Rubber and Plastics	San Diego	CA
08261	Spectra Strip (Amphenol)	Garden Grove	
08289	Blinn Delbert Co.	Pomona	CA
08353	Bristol Co. of Canada	Toronoto, Ont	Canada
08730	Ostby & Barton (Vemaline Prod. Div.)	Warwick	RI
08779	Signal Transformer	Brooklyn	NY
09214	GE (Semiconductor Prod. Div)	Auburn	NY
09353	C & K Components	Newton	MA
09922	Burndy Corp.	Norwack	CT
10389	Chicago Switch	Chicago	IL
11815	Cherry/Textron (Fastener Div)	Santa Ana	CA
12406	Elpac Electronics	Santa Ana	CA
12697	Clarostat Mfg.	Dover	NH
13103	Thermalloy Company	Dallas	TX
13150	Vernitron Corp (Beau Prod.)	Laconia	NH
13604	Sperry Corp. Elec. Systems	Great Neck	NY
13919	Burr-Brown	Tucson	AZ
14099	Semtech Corporation	Newbury Park	CA
14604	Elwood Sensors Inc.	Cranston	RI
14655	Cornell-Dubilier Elect. Corp.	Newark	NJ
14726	Hollingsworth Co.	Phoenixville	PA
14752	Electro Cube, Inc.	San Gabriel	CA
14908	Electronic Instrument and Specialty Corp.	Stoneham	MA
15238	ITT Semiconductors	Lawrence	MA
15454	Ametek Znk (Rodan Div)	Anaheim	CA
15636	Elec-Trol Inc.	Northridge	CA
15801	Fenwall Electronics	Framingham	MA
15818	Ameico Teledyne, Inc.	Mt. View	CA
15912	Ansley	Los Angeles	CA
16067	California Instruments Co.	San Diego	CA
16758	Delco Radio Div., Gen. Mtrs.	Kokomo	IN
16956	Dennison	Framingham	MS
17856	Siliconix, Inc.	Santa Clara	CA
18076	Umpco	City of Industry	CA
18178	Vactec, Inc.	Maryland Heights	MO
18310	Concord Electronics Corp.	New York	NY
18324	Signetics	Sunnyvale	CA
18612	Vishay Instruments, Inc.	Malvern	PA
18677	Scambe Mfg. Co. (Zero Corp.)	Monterey Park	CA
18722	RCA	Mountaintop	PA
18736	Voltronics Corp.	Hanover	NJ
19080	Robison Company	Hawthorne	CA
21604	Buckeye Stamping Company	Columbus	OH
21845	Solitron Devices (Semi-conductor Group)	Riviera Beach	FL
22599	Elastic Stop Nut Corp.	Van Nuys	CA
23050	Product Components Corp.	Hastings-on-Hudson	NY
23936	Pamotor, Inc.	San Francisco	CA
24011	ECC	Burlington	MA
24355	Analog Devices, Inc.	Norwood	MA
24444	General Semiconductor Inc.	Tempe	AZ
24796	Parelco, Inc.	Paramount	CA
24931	Specialty Connector Co., Inc.	Greenwood	IN
24972	AEG-Telefunken Corp.	Summerville	NJ
25403	Amperex Electronic Corp.	Slatersville	RI
25497	Meter Master	Los Angeles	CA
26405	Marathon Electric Mfg. Corp.	Bowling Green	OH
26806	American Hettler, Inc.	Costa Mesa	CA
27014	National Semi-Conductor Crp.	Santa Clara	CA
27191	Cutler-Hammer, Inc.	Milwaukee	WI
27264	Molex	Downers Grove	IL
27335	B & B Motor & Control Corp.	New York	NY
27556	IMB Electronic Products	Santa Fe Springs	CA
27683	Varo, Inc.	St. Garland	TX
27735	F-Dyne Electronics	Bridgeport	CT
27832	Hughes Aircraft	Newport Beach	CA
28480	Hewlett-Packard Co.	Palo Alto	CA
28520	Heyman Mfg. Company (Heyco)	Kenilworth	NJ
28606	Echlin Ltd.	Rexdale Ont.	Canada
29372	Rexnord Inc. Tridair Ind.	Torrance	CA
29593	Bussco Eng. Inc.	El Segundo	CA
30039	International Components Crp.	Asbury Park	NJ
30161	Aavid Engineering, Inc.	Laconia	NH
30897	Dorann Company	Sylmar	CA
30983	Electra/Midland (Mepco/ Electra)	San Diego	CA
31827	Budwig Mfg. Co.	Ramona	CA
31951	Triridge, Inc.	Pittsburg	PA
32293	Intersil	Cupertino	CA
32559	Bivar, Inc.	Santa Ana	CA
32997	Bourns Inc. (Trimpot Div)	Riverside	CA
33005	Jewell Electrical Inst. Inc.	Manchester	NH
33335	Logic Dynamics, Inc.	Gardena	CA
33716	Kingsbacher Murray Co.	Los Angeles	CA
33855	Ducommun, Inc.	Los Angeles	CA
33901	Colbec Corp.	Irvington	NJ
34238	Mille Resistor Co.	Los Alamitos	CA
34333	Silicon General	Westminster	CA
34649	Intel Corporation	Santa Clara	CA
35007	Aerovox Canada Ltd.	Amherst NS	Canada
37964	Linear Technology, Inc.	Burlington, Ont	CAN
44655	Ohmite Manufacturing Co.	Skokie	IL
45722	Parker-Kalon	Clifton	NJ
46384	Penn. Eng. and Mfg. Corp.	Doylestown	PA
50157	Midwest Components, Inc.	Muskegon	MI
50522	Monsanto, Electronic Special Products	Cupertino	CA
50558	Electronic Concepts, Inc.	Eatontown	NJ
50811	Mouser Corp.	Santee	CA
51167	Aries Electronics, Inc.	Frenchtown	NJ
51506	Accurate Screw Machine Co.	Nutley	NJ
51705	ICO/Rally	Palo Alto	CA
52072	Circuit Assembly Corp.	Costa Mesa	CA
52745	Timco	Los Angeles	CA
53076	Kintex, Inc.	Buffalo	NY
53495	Data Components, Inc.	Gardena	CA
54361	Edwards Sheet Metal Works	Fredericktown	OH
54407	Power-One Co.	Camarillo	CA
55322	Samtek, Inc.	New Albany	NY
55566	RAF Electronic Hardware, Inc.	Seymour	CT
56289	Sprague Electric Company	North Adams	MA
56637	RCD Components, Inc.	Manchester	NH
57640	United Chem-Con Corp.	Philadelphia	PA
57856	Kel-Am, Inc.	Eldon	MO
58474	Superior Electric Company	Bristol	CT
59730	Thomas and Betts Company	Elizabeth	NJ
59993	International Rectifier Semiconductor Div.	El Segundo	CA
60395	Xicor, Inc.	Milditas	CA
61394	Seeq Technology, Inc.	San Jose	CA
61441	Saronix	Palo Alto	CA
61529	Aromat Corp.	Mountainside	NJ
61735	Pulse Engineering, Inc.	College Park	MD
62483	Densitron Corp. of America	Torrance	CA
62643	United Chemicon, Inc.	Rosemont	IL
62786	Hitachi America Ltd.	San Jose	CA
63743	Ward Leonard Electric Co.	Mt. Vernon	NY
63791	Star Micronics, Inc.	New York	NY
70318	Allmetal Screw Prod. Co.	Garden City	NY
70903	Belden Manufacturing Co.	Chicago	IL
71218	Bud Industries, Inc.	Willoughby	OH
71279	Cambridge Thermionic Corp.	Cambridge	MA
71400	Buzzman Mfg. Div. McGraw-Edison, Co.	St. Louis	MO
71450	CTS Corporation	Elkhart	IN
71468	ITT Cannon Electric, Inc.	Los Angeles	CA
71590	Centralab Div. Globe-Union	Milwaukee	WI
71707	Coto-Coil	Providence	RI
71744	Chicago Miniature Lampworks	Chicago	IL
71785	Cinch Manufacturing Company	Chicago	IL
71984	Dow Corning Corp.	Midland	MI
72136	Elmenco (Electro Motive)	Willimantic	CT
72619	Dialight Corporation	Brooklyn	NY
72699	General Instruments	Newark	NJ
72982	Erie Technological Prod. Inc.	Erie	PA
73138	Beckman Instruments, Inc.	Fullerton	CA
73612	Consolidated Electronic Wire and Cable Corp.	Chicago	IL
73734	Federal Screw Products, Inc.	Chicago	IL
74193	Heinemann Electric Company	Trenton	NJ
74545	Harvey Hubbell, Inc.	Bridgeport	CT
74840	Illinois Condenser Co.	Chicago	IL
74970	E.F. Johnson Company	Waseca	MN
75042	TRW Electronic Components	Philadelphia	PA
75382	Kulka Electric Corporation	Mt. Vernon	NY
75582	Leviton Mfg. Co.	Little Neck	NY
75915	Littelfuse, Inc.	Des Plaines	IL
76385	Minor Rubber Co., Inc.	Bloomfield	NJ
77062	Pabst Eng. Equipment Co.	Elizabeth	NJ
77132	United-Carr Inc., Patwin Div	Waterbury	CT
77342	Potter and Blumfield Div, AMF	E. Princeton	IN
78189	Shakeproof Div. IL Tool Works	Chicago	IL
78553	Tinnerman Products, Inc.	Cleveland	OH
79130	Johns-Manville Products Corp	Chicago	IL
79136	Waldes Kohinoor Inc.	Long Island City	NY
79963	Zierick Mfg. Corp.	New Rochelle	NY
80031	Mepco/Electra	Morristown	NJ
80223	United Transformer Co.	New York	NY
80294	Bourns, Inc.	Riverside	CA
80495	High Voltage Engineering Corp (Anderson Pwr Prod. Div)	Brighton	MA
81095	Triad Transformer Corp.	Venice	CA
81312	Winchester Electronics	Oakville	CT
81348	(Fed. Specs) Promulgated by General Services Administration Washington DC		
81349	Military Specification or Commercial Generic Number		
81541	Airpax Corp.	Cambridge	MD
81603	Raco Products Co.	Chicago	IL
81851	Bentley-Harris Mfg Co.	Lionville	PA
82104	Standard Grigsby	Aurora	IL
82389	Switchcraft, Inc.	Chicago	IL
82877	Rotron Mfg. Co., Inc.	Woodstock	NY
82893	Vector Electronics, Inc.	Sylmar	CA
83330	Herman H. Smith, Inc.	Brooklyn	NY
83486	Elco Tool & Screw Corp.	Rockford	IL
85480	Brady W.H. Co.	Milwaukee	WI
86684	RCA	Harrison	NJ
86928	Seastrom Mfg. Co., Inc.	Glendale	CA
87034	Marco-Oak Industries	Anaheim	CA
88245	Useco Div., Litton Ind.	Van Nuys	CA
90201	Mallory Capacitor Co.	Indianapolis	IN
91506	Augat, Inc.	Attleboro	MA
91637	Dale Electronics, Inc.	Columbus	NE
91662	Elco Corporation	Willow Grove	PA
91802	Industrial Devices, Inc.	Edgewater	NJ
91833	Keystone Electronics Corp.	New York	NY
91967	National Tel-Tronics	Meadville	PA
92194	Alpha Wire Corp.	Elizabeth	NJ
93303	Pentagon Products Co.	Washington	DC
94222	Southco, Inc.	Lester	PA
94696	Magnecraft Electric Co.	Chicago	IL
95146	Alco Electronic Prod., Inc.	No. Andover	MA
95303	RCA	Cincinnati	OH
95354	Methode Manufacturing Corp.	Rolling Meadows	IL
95566	Arnold Engineering Co.	Marengo	IL
95987	Weckesser Company, Inc.	Chicago	IL
96906	Military Std		
97525	Electronic Engineering Co.	Santa Ana	CA
98159	Rubber Teck, Inc.	Gardena	CA
98291	Sealecto Corp.	Mamaroneck	NY
98376	Zero Mfg. Co. (West)	Burbank	CA
98978	IERC	Burbank	CA
99017	Protective Closures Co., Inc. (Capluge Div)	Buffalo	NY
99217	Bell Industries, Inc.	Delavan	WI
99742	Permacell	New Brunswick	NJ
99743	IMC	Maywood	CA
99800	Delevan Electronics Corp.	Aurora	NY

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS CORPORATION warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are tubes, fuses, and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair, if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, including the model number and serial number. On receipt of this information, service information or a Return Material Authorization (RMA) number will be given. Add RMA No. to shipping label. Pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No., or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS, San Diego, CA. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

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